

REMARKS/ARGUMENTS

Reconsideration of this application in light of the above amendments and following comments is courteously solicited.

Claims 1-4 and 16-20 were rejected under 35 U.S.C. §103 as being unpatentable over EP 0411882 or EP 0872564.

The invention as claimed in the amended claim 1 is directed to a copper base alloy consisting essentially of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, and the balance being copper and unavoidable impurities, wherein a difference in temperature between liquidus and solidus lines is 30°C or more. That is, the invention as claimed in the amended claim 1 is directed to a Cu-Zn-Sn alloy (a copper base alloy containing Zn and Sn as essential elements) which contains a predetermined amount of carbon and wherein a difference in temperature between liquidus and solidus lines is 30°C or more.

As is well known, brasses containing zinc in copper have excellent characteristics, such as excellent workability and press punching quality and low costs, and are utilized as the materials of many electric parts, such as connectors. However, it is required to further improve the strength, spring characteristic, stress relaxation resistance and stress corrosion cracking resistance of brasses in order to cope with the miniaturization of parts and the deterioration of working environments. In such circumstances, there have been proposed methods for improving the above described characteristics by adding a predetermined amount of Sn to a Cu-Zn alloy. Such a Cu-Zn-Sn alloy is formed as a plate having a predetermined thickness usually by a method comprising the steps of carrying out the longitudinal continuous casting, heating the obtained ingot by a heating furnace, extending the heated ingot by hot rolling, and thereafter, repeating cold rolling and annealing.

Although the mechanical characteristics, such as tensile strength and 0.2% proof stress, stress relaxation resistance and stress corrosion cracking resistance of Cu-Zn-Sn alloys can be improved by the addition of Sn, it is desired to improve the hot workability thereof. That is, there are some cases where Cu-Zn-Sn alloys may be broken during hot rolling to deteriorate the surface quality and yields of products, so that it is desired to improve the hot workability of Cu-Zn-Sn alloys.

One of the reasons why the hot workability is deteriorated by adding Sn to Cu-Zn alloys is that the temperature difference between the liquidus and solidus lines of the alloys is increased by adding Sn thereto. Thus, Sn and Zn segregate during casting, and phases having low melting points remain during solidification. For example, phases having low melting points, such as a Cu-Sn epsilon phase, a Cu-Zn gamma phase and a phase formed by solid-dissolving Cu and/or Zn in an Sn solid solution, remain in Cu-Zn-Sn alloys. Thus, the remaining second phase is dissolved during overheating when hot rolling is carried out, so that the hot workability deteriorates. Therefore, it is required to provide a copper base alloy having a more excellent hot workability. If Sn is added to a Cu-Zn alloy, the temperature difference between solidus and liquidus lines is easy to be greater than that when Sn is added to Cu, so that it is desired to improve the hot workability.

In order to obtain a Cu-Zn-Sn alloy having an improved hot workability, the inventors were diligently studied and found that it is possible to greatly improve the hot workability of a Cu-Zn-Sn alloy by causing the Cu-Zn-Sn alloy to contain a predetermined amount of carbon.

If an ingot of a Cu-Zn-Sn alloy, which has a large temperature difference between liquidus and solidus lines, is

hot-rolled, there are some cases where hot cracks may be produced in the edge portion(s) or surface of the ingot. However, if the copper base alloy contains 80 to 1000 ppm of C, it is possible to effectively inhibit hot cracks from being produced.

EP 0411882 discloses copper-base alloys consisting essentially of 5 to 30 wt% of Ni, 0.5 to 3 wt% of B, 1 to 5 wt% of Si, 4 to 30 wt% of Fe, at least one of 3 to 15 wt% of Sn and 3 to 30 wt% of Zn, and the remainder being Cu and unavoidable impurities. That is, the copper-base alloys disclosed in EP 0411882 are copper-base alloys containing Ni, B and Fe in addition to Sn and Zn as essential elements, and are quite different from the copper base alloy as claimed in the amended claim 1. Therefore, EP 0411882 fails to disclose or suggest any copper base alloys consisting essentially of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, and the balance being copper and unavoidable impurities, wherein a difference in temperature between liquidus and solidus lines is 30°C or more.

EP 0411882 also discloses that C is added to form carbide hard particles which further increase the wear-resistance. However, EP 0411882 fails to disclose or suggest that the hot workability of a Cu-Zn alloy is deteriorated by adding Sn thereto since the temperature difference between the liquidus and solidus lines of the alloy is increased by adding Sn thereto. In addition, EP 0411882 fails to disclose or suggest that it is possible to greatly improve the hot workability of a Cu-Zn-Sn alloy by causing the Cu-Zn-Sn alloy to contain a predetermined amount of carbon.

EP 0872564 discloses copper based alloys consisting essentially of 15 to 35 wt% of Zn, 7 to 14 wt% of Ni, 0.1 to 2

wt% of Mn, 0.01 to 0.5 wt% of Fe, 0.0005 to 0.1 wt% of P, at least one element selected from the group consisting of 0.001 to 0.9 wt% of Si, 0.0003 to 0.02 wt% of Pb, and 0.0003 to 0.01 wt% of C, the total content of the selected at least one element being limited to a range of 0.0006 to 0.9 wt%, and the balance of Cu and inevitable impurities. That is, the copper based alloys disclosed in EP 0872564 are copper based alloys containing Ni, Mn, Fe and P as essential elements, and are quite different from the copper base alloy as claimed in the amended claim 1. Therefore, EP 0872564 fails to disclose or suggest any copper base alloys consisting essentially of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, and the balance being copper and unavoidable impurities, wherein a difference in temperature between liquidus and solidus lines is 30°C or more.

EP 0872654 also discloses that C is added to increase the rupture section ratio of the blankout section to reduce the amount of wear of the blanking die. However, EP 0872654 fails to disclose or suggest that the hot workability of a Cu-Zn alloy is deteriorated by adding Sn thereto since the temperature difference between the liquidus and solidus lines of the alloy is increased by adding Sn thereto. In addition, EP 0872654 fails to disclose or suggest that it is possible to greatly improve the hot workability of a Cu-Zn-Sn alloy by causing the Cu-Zn-Sn alloy to contain a predetermined amount of carbon.

Therefore, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the amended claim 1.

The invention as claimed in the amended claim 2 is directed to a copper base alloy essentially consisting of: 8 to 45 wt% of zinc; 0.2 to 12.0 wt% of tin; 80 to 1000 ppm of carbon; one or

more elements which are selected from the group consisting of 0.01 to 3.0 wt% of silicon, 0.01 to 0.3 wt% of nickel, 0.01 to 5.0 wt% of iron, 0.01 to 5.0 wt% of chromium, 0.01 to 2.5 wt% of cobalt, 0.001 to 4.0 wt% of bismuth, 0.05 to 4.0 wt% of lead, 0.01 to 2.0 wt% of magnesium, 0.01 to 0.5 wt% of phosphorus, 0.01 to 0.1 wt% of calcium, 0.01 to 0.1 wt% of yttrium, 0.01 to 0.1 wt% of strontium, 0.01 to 1.0 wt% of beryllium, 0.01 to 0.5 wt% of zirconium, 0.1 to 3.0 wt% of niobium, 0.1 to 3.0 wt% of vanadium, 0.1 to 3.0 wt% of hafnium, 0.1 to 3.0 wt% of molybdenum and 0.1 to 3.0 wt% of tantalum, and the balance being copper and unavoidable impurities, wherein a difference in temperature between liquidus and solidus lines is 30°C or more. That is, the invention as claimed in the amended claim 2 is directed to the same Cu-Zn-Sn alloy as that in the amended claim 1, except that the alloy contains relatively small amounts of additional elements to an extent that the difference in temperature between liquidus and solidus lines is maintained to be 30°C or more.

The copper-base alloys disclosed in EP 0411882 are copper-base alloys containing a large amount (5 to 30 wt%) of Ni as essential elements, and are quite different from the copper base alloy as claimed in the amended claim 2. Therefore, EP 0411882 fails to disclose or suggest any copper base alloys consisting essentially of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, relatively small amounts of additional elements, and the balance being copper and unavoidable impurities, wherein a difference in temperature between liquidus and solidus lines is 30°C or more.

The copper based alloys disclosed in EP 0872564 are copper based alloys containing Mn and a large amount (7 to 14 wt%) of Ni as essential elements, and are quite different from the

copper base alloy as claimed in the amended claim 2. Therefore, EP 0872564 fails to disclose or suggest any copper base alloys consisting essentially of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, relatively small amounts of additional elements (essentially containing no manganese), and the balance being copper and unavoidable impurities, wherein a difference in temperature between liquidus and solidus lines is 30°C or more.

Therefore, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the amended claim 2. Similarly, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the amended claims 19 and 20, and newly added claims 21 and 22.

The invention as claimed in the newly added claim 29 is directed to a copper base alloy essentially consisting of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, and the balance being copper and unavoidable impurities, wherein a phase of the copper base alloy other than an alpha phase has a volume percentage of 20 % or less. According to the invention as claimed in the newly added claim 30, the phase of the copper base alloy other than the alpha phase has a melting point of 800 °C or less.

If the phase of the copper base alloy other than the alpha phase has a volume percentage thereof of not less than 20%, there are some cases where the phase of the copper base alloy other than the alpha phase may melt to produce hot cracks during heating. Similarly, if the phase of the copper base alloy other than the alpha phase has a melting point of less than 800 °C, there are some cases where the phase of the copper base alloy other than the alpha phase may melt to produce hot cracks during

heating.

EP 0411882 and EP 0872564 fail to disclose or suggest that a phase of the copper base alloy other than an alpha phase has a volume percentage of 20 % or less and that the phase of the copper base alloy other than the alpha phase has a melting point of 800 °C or less. In addition, the copper-base alloys disclosed in EP 0411882 are copper-base alloys containing Ni, B and Fe in addition to Sn and Zn as essential elements, and are quite different from the copper base alloy as claimed in the amended claim 29. Moreover, the copper based alloys disclosed in EP 0872564 are copper based alloys containing Ni, Mn, Fe and P as essential elements, and are quite different from the copper base alloy as claimed in the amended claim 29.

Therefore, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the newly added claims 29 and 30.

The invention as claimed in the newly added claim 32 is directed to a copper base alloy essentially consisting of: 8 to 45 wt% of zinc; 0.2 to 12.0 wt% of tin; 80 to 1000 ppm of carbon; one or more elements which are selected from the group consisting of 0.01 to 3.0 wt% of silicon, 0.01 to 0.3 wt% of nickel, 0.01 to 5.0 wt% of iron, 0.01 to 5.0 wt% of chromium, 0.01 to 2.5 wt% of cobalt, 0.001 to 4.0 wt% of bismuth, 0.05 to 4.0 wt% of lead, 0.01 to 2.0 wt% of magnesium, 0.01 to 0.5 wt% of phosphorus, 0.01 to 0.1 wt% of calcium, 0.01 to 0.1 wt% of yttrium, 0.01 to 0.1 wt% of strontium, 0.01 to 1.0 wt% of beryllium, 0.01 to 0.5 wt% of zirconium, 0.1 to 3.0 wt% of niobium, 0.1 to 3.0 wt% of vanadium, 0.1 to 3.0 wt% of hafnium, 0.1 to 3.0 wt% of molybdenum and 0.1 to 3.0 wt% of tantalum, and the balance being copper and unavoidable impurities, wherein a phase of the copper base alloy other than an alpha phase has a

volume percentage of 20 % or less. According to the invention as claimed in the newly added claim 33, the phase of the copper base alloy other than the alpha phase has a melting point of 800 °C or less.

Second phases other than alpha phase are produced in accordance with the combination of the additional elements as claimed in the newly added claim 32. The second phases include Cu-Zn beta (β), gamma (γ) and epsilon (ϵ) phases, and Cu-Sn beta (β), epsilon (ϵ), eta (η) and delta (δ) phases. There are also Ni-Si compounds obtained by adding both of Ni and Si, and Ni-P compounds and Fe-P compounds obtained by adding both of Ni and Fe or P. The simple substance of Cr, Bi or Pb forms a deposit. Such deposits formed by adding additional elements, e.g., deposits having a high melting point formed by adding Cr, Ni-Si compounds and Ni-P compounds, have the function of improving the stress relaxation resistance of a copper base alloy. Deposits formed by adding Bi or Pb have the function of improving the free-cutting workability of a copper base alloy. However, if the melting point of the second phases and the melting point of third phases in some cases are 800 °C or less, and if the volume percentage thereof is 20% or more, there are some cases where the second and third phases may melt to produce hot cracks during heating. Therefore, the volume percentage of phases having a low melting point of 800 °C or less other than alpha phase is preferably 20% or less.

EP 0411882 and EP 0872564 fail to disclose or suggest that a phase of the copper base alloy other than an alpha phase has a volume percentage of 20 % or less and that the phase of the copper base alloy other than the alpha phase has a melting point of 800 °C or less. In addition, the copper-base alloys disclosed in EP 0411882 are copper-base alloys containing a large amount

(5 to 30 wt%) of Ni as essential elements, and are quite different from the copper base alloy as claimed in the newly added claim 32. Moreover, the copper based alloys disclosed in EP 0872564 are copper based alloys containing Mn and a large amount (7 to 14 wt%) of Ni as essential elements, and are quite different from the copper base alloy as claimed in the newly added claim 32.

Therefore, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the newly added claims 32 and 33. Similarly, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the newly added claims 35, 36, 38, 39, 41, 42, 44 and 45.

The invention as claimed in the newly added claim 47 is directed to a copper base alloy essentially consisting of 8 to 45 wt% of zinc, 0.2 to 12.0 wt% of tin, 80 to 1000 ppm of carbon, and the balance being copper and unavoidable impurities, wherein $X + 5Y \leq 50$, assuming that the content of zinc is X (wt%) and the content of tin is Y (wt%).

If Sn is added to a Cu-Zn alloy, it is possible to improve the stress relaxation resistance and stress corrosion cracking resistance of the Cu-Zn alloy. However, the difference between liquidus and solidus lines increases in the presence of both of Zn and Sn, and cracks are easily produced during hot working even in the presence of C. In order to obtain a good hot workability, the alloy preferably satisfies $X + 5Y \leq 50$ assuming that the content of zinc is X (wt%) and the content of tin is Y (wt%).

EP 0411882 and EP 0872564 fail to disclose or suggest that $X + 5Y \leq 50$, assuming that the content of zinc is X (wt%) and the content of tin is Y (wt%). In particular, EP 0411882 and EP

0872564 fail to disclose or suggest any copper bases alloy satisfying $X + 5Y \leq 50$, assuming that the content of zinc is X (wt%) and the content of tin is Y (wt%), although all of the copper base alloys in Examples 1, 2 and 8, which correspond to the copper base alloys as claimed in the newly added claim 47, satisfy $X + 5Y \leq 50$, assuming that the content of zinc is X (wt%) and the content of tin is Y (wt%). In addition, the copper-base alloys disclosed in EP 0411882 are copper-base alloys containing Ni, B and Fe in addition to Sn and Zn as essential elements, and are quite different from the copper base alloy as claimed in the newly added claim 47. Moreover, the copper based alloys disclosed in EP 0872564 are copper based alloys containing Ni, Mn, Fe and P as essential elements, and are quite different from the copper base alloy as claimed in the newly added claim 47.

Therefore, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the newly added claim 47.

The invention as claimed in the newly added claim 48 is directed to a copper base alloy essentially consisting of: 8 to 45 wt% of zinc; 0.2 to 12.0 wt% of tin; 80 to 1000 ppm of carbon; one or more elements which are selected from the group consisting of 0.01 to 3.0 wt% of silicon, 0.01 to 0.3 wt% of nickel, 0.01 to 5.0 wt% of iron, 0.01 to 5.0 wt% of chromium, 0.01 to 2.5 wt% of cobalt, 0.001 to 4.0 wt% of bismuth, 0.05 to 4.0 wt% of lead, 0.01 to 2.0 wt% of magnesium, 0.01 to 0.5 wt% of phosphorus, 0.01 to 0.1 wt% of calcium, 0.01 to 0.1 wt% of yttrium, 0.01 to 0.1 wt% of strontium, 0.01 to 1.0 wt% of beryllium, 0.01 to 0.5 wt% of zirconium, 0.1 to 3.0 wt% of niobium, 0.1 to 3.0 wt% of vanadium, 0.1 to 3.0 wt% of hafnium, 0.1 to 3.0 wt% of molybdenum and 0.1 to 3.0 wt% of tantalum, and

the balance being copper and unavoidable impurities, wherein $X + 5Y + 4Z \leq 50$, $X + 4Z \leq 50$, and $5Y + 4Z \leq 45$, assuming that the content of zinc is X (wt%), the content of tin is Y (wt%) and the total amount of said one or more elements is Z (wt%).

If additional elements, such as Si, Ni, Fe, Cr, Co, Bi, Pb, Mg, P, Ca, Y, Sr, Be, Zr, Nb, V, Hf, Mo and Ta, are added to the alloy, the hot workability thereof varies. In such a case, the alloy preferably satisfies all of $X + 5Y + 4Z \leq 50$, $X + 4Z \leq 50$ and $5Y + 4Z \leq 45$, assuming that the content of zinc is X (wt%), the content of tin is Y (wt%) and the total amount of the other additional elements is Z (wt%). If the amount of the additional elements exceeds the above described range, the melting/solidifying range is widen during casting, so that cracks are easily produced during hot working even if the alloy is caused to contain C.

EP 0411882 and EP 0872564 fail to disclose or suggest that $X + 5Y + 4Z \leq 50$, $X + 4Z \leq 50$, and $5Y + 4Z \leq 45$, assuming that the content of zinc is X (wt%), the content of tin is Y (wt%) and the total amount of said one or more elements is Z (wt%). In particular, EP 0411882 and EP 0872564 fail to disclose or suggest any copper base alloys satisfying all of $X + 5Y + 4Z \leq 50$, $X + 4Z \leq 50$, and $5Y + 4Z \leq 45$, assuming that the content of zinc is X (wt%), the content of tin is Y (wt%) and the total amount of said one or more elements is Z (wt%), although all of the copper base alloys in Examples 5-7, which correspond to the copper base alloys as claimed in the newly added claim 48, satisfy $X + 5Y + 4Z \leq 50$, $X + 4Z \leq 50$, and $5Y + 4Z \leq 45$, assuming that the content of zinc is X (wt%), the content of tin is Y (wt%) and the total amount of said one or more elements is Z (wt%). In addition, the copper-base alloys disclosed in EP

0411882 are copper-base alloys containing a large amount (5 to 30 wt%) of Ni as essential elements, and are quite different from the copper base alloy as claimed in the newly added claim 48. Moreover, the copper based alloys disclosed in EP 0872564 are copper based alloys containing Mn and a large amount (7 to 14 wt%) of Ni as essential elements, and are quite different from the copper base alloy as claimed in the newly added claim 48.

Therefore, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the newly added claim 48. Similarly, it would not have been obvious to one of ordinary skill in the art to make any copper base alloys as set forth in the newly added claims 49-52.

Accordingly, it is believed that the amended and newly added claims patentably distinguish the invention from the prior art.

An earnest and thorough attempt has been made by the undersigned to resolve the outstanding issues in this case and place same in condition for allowance. If the Examiner has any questions or feels that a telephone or personal interview would be helpful in resolving any outstanding issues which remain in this application after consideration of this amendment, the Examiner is courteously invited to telephone the undersigned and the same would be gratefully appreciated.

It is submitted that the claims as amended herein patentably define over the art relied on by the Examiner and early allowance of same is courteously solicited.

Enclosed herewith is a check in the amount of \$4550.00 for the extra claims and the independent claims added in connection with this amendment.

If any fees are required in connection with this case, it is respectfully requested that they be charged to Deposit Account No. 02-0184.

Respectfully submitted,
YASUO INOHANA ET AL.

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I, Rachel Piscitelli, hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313" on November 29, 2006.

Rachel Piscitelli